MULTI CURIE FLUORINE-18 IN IBA TITANIUM TARGET

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Most of the targets used to produce fluoride-18 are made of silver or titanium. Some of them have been described in the literature. A new titanium target used for the production of high radioactivity amounts of fluoride-18 has been designed. This target is very similar to the silver target presented by IBA in Heidelberg in 1997 (1) and used for the same purpose. This target has been set up and tested on a Cyclone-18/9 (18 MeV protons and 9 MeV deuterons) designed by IBA.

Most of our attention was focused on the upgrade of the heat exchange surface. To improve the heat transfer we have strongly reduced the thickness of the material between the irradiated cavity and the cooling system. The thermal conductivity of titanium is about 20 times lower than the conductivity of silver (see table 1). On the other hand, the risk to establish strong bonds between fluoride-18 and the metal is raised when we use titanium (see table 1). In this case the production remains efficient but the extraction of the radioactivity is inadequate. A major problem also concerns the activation of the titanium target through p,n nuclear reaction on ^{48}Ti that leads to the production of ^{48}V (γ : 1312 KeV, T1/2 : 15.97 days). Our goal when we have decided to change the material was to reduce the amount of metallic species that is leached by the silver target and that is suspected-without clear evidence-to poison the 18FDG chemistry. On the other hand, this metallic dust is sometimes at the origin of the blocking of the transfer line tube.

The main challenge linked to the design of this new target consists in keeping the very high amount of radioactivity which was usually produced at 18 MeV when we used a silver target : 4 Ci fluoride-18 at least. The results obtained are described in table 2. The limitation of the beam intensity we can put on this target is imposed by the internal pressure that has been measured (see table 3) on line. Four tests have been conducted to synthesise ^{18}FDG with a radioactivity amount of fluoride-18 higher than 4 Ci; about 2 Ci of ^{18}FDG have been produced (see table 4).

This target has demonstrated its ability to produce large amounts of good quality fluoride-18. For the future we are studying a local shielding of the target and we continue to accumulate target and ^{18}FDG production data.

Table 1 : comparison of thermal conductivity between silver and titanium and bond strength between fluor and respectively titanium and silver

Material	Bond strength(kJ/mol)	Thermal conductivity (W/cm.k)
Silver	Ag-F : 354	4.29
Titanium	Ti-F : 569	0.22

Table 2 : summary of the performances of the titanium target

Energy (MeV)	Beam intensity (µA)	Irradiation time(minutes) (minutes)	Thick target yield (mCi/µA.sat)	Radioactivity EOB (Ci)
18	37	120	234±10 (n=30)	4.6±0.2 (n=30)

Table 3 : evolution of the pressure with the beam current at 18 MeV

I (µA)	10	15	20	25	30	35	36	37
P (bar)	1.4	2.1	4	8.2	15.7	31.8	34.7	38.1

Table 4 : 18FDG yield EOB at high fluoride-18 radioactivity

Starting radioactivity (Ci)	Radiochemical yield EOB (%)	Radiochemical yield EOS (%)	^{18}FDG radioactivity EOS (Ci)
3.9±0.2	60±6	48±5	1.6-2.2 (n=4)

REFERENCES

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2. Ghyoot M., Verbruggen R., Schmitz F., Ohkoshi M., Vamecq F., Jongen Y., *38th Meeting of the Japanese Society of Nuclear Medicine, 5-9 October 1998.*

DISCUSSION

John Clark: Is Amsterdam the only place where titanium targets are in use?

Frederic Schmitz: Peter Kruijer or Peter van Leuffen can make a comment.

John Clark: You are showing joint data I guess.

Frederic Schmitz: They are the only one and we will see for the future. Well, some chemists absolutely want to stay with silver targets and some chemists absolutely want to have a titanium target but we can offer both.

John Clark: Does the silver target have a similar service plateau?

Frederic Schmitz: Yes, indeed it is exactly the same for the silver target, so it is quite easy to switch from one to the other and the problem we met with a silver target is silver dust because silver is a very soft material.

John Clark: Is it coming back out of the water and getting into the FDG system?

Frederic Schmitz: Yes.

John Clark: This is a problem, I think, for many people not only blocking pipes but also wrecking the FDG synthesis system. Any comments on silver targets that are repeatable in public? Some people like them and some people hate them. Marc Berridge is going to hate them.

Marc Berridge: I went with the silver target and liked it for a long time but I did notice that I had to clean it once a month. I know that is not the experience of everyone but it just depends on the size of your target and the beam energy and the phase of the moon!

John Clark: and probably the quality of the water.

Marc Berridge: I think we can do something about that. You just distill it and you can get good quality water but I don't have a lot of proof of this. I've noticed that in N-13 targets you make nitrate, nitrite, and if you pressurize them with hydrogen you get N_2 which says there is a fair amount of nitrogen knocking around in there so that means that in a regular target when you are making ^{18}F, you still have that nitrogen there and you still are making nitrate and nitrite out of it because it's the carrier and what does that do in a target? It becomes nitric acid. I've done this, you take a silver foil and you drop it into very dilute nitric acid and leave it over night, you get a small film of white deposit on the silver which looks just like the white deposit you get on a target that has been irradiated for quite a while. I suspect this has something to do with what is going on in there and we are getting some silver salts, maybe silver nitrate, out and that eventually when it builds up enough you start to have chemical problems and have to clean it off. Jeanne Link seems to have some comments on this.

Jeanne Link: I'm not going to talk about whether you want a silver target or a titanium target because if you are an engineer you want titanium, if you are a chemist you think about silver. Silver is the softest acid so silver does get into the solution but the chemistry of silver is pretty well known. You do get radiolytic nitrate so you get silver nitrate. The other thing is, when you distill water you know when you do a trace metals analysis you find sodium in your water. Almost no stills are sodium free and when you get sodium you get some chloride, you have to have a counter ion. What you end up with is a lot of ions in these targets. Another issue relates to the ion exchange resins we use as they open their pores you get chloride, so then you get a little bit of silver chloride and now that is when you get a white or a pink solid in your lines. So it's just a clean up problem but it depends how much you want to work at keeping the system clean.

Dave Smith: We have an RDS-112. Some of the experience that we have seen on that have got dual extraction and have run beam line number 1 and beam line number 4. We do an [^{16}O] water flush at the end of a bombardment. My target 1 has actually been running for over 3,000 microamp hours without a rebuild and still giving a good 107mCi per microamp saturation yields on it. I see very little slurry come off that target. Same respect, beam line number 4, I have to rebuild my target occasionally and I think it is more a function of beam density hot spots, beam line 1 is far enough out of the magnet in that particular system and we probably have more diffuse beam pattern on the target. We get back to that heat removal and possibly that area of gasses between the water and the back of the target or the thing like that.

Unidentified RDS-112 user: I totally eliminated this problem because we reduced the collimator down to 7 mm and the diameter of the target just after the collimator is 10 mm. I do not see any possibility to have a wrong beam shape or a beam which can hurt the wall of the cavity. It is not possible in this case.

Another Unidentified RDS-112 user: I also obtained 8 mm collimators from CTI and installed it on the target and matters got worse for me. I think that it was more of an effect of the front end of the target that was heating up from the beam energy absorbed by the collimator and caused my front window cooling to have a problem which in turn causes that same problem. We live and we learn.

Collin McKinney: We have a pair of silver body targets that we use at 12 MeV entrance energy. They are basically CTI targets that we use a degrader in front of and we have solved a lot of our contamination problems and cleaning problems. We went from a silver entrance window to a tantalum entrance window. We use to get stalactites on the back of the target if you let them go for very long. Now I've got one target that we haven't cleaned for a year-and-a-half. We do rinse that target but we don't see that build-up any longer. So this suggestion is a way to clear up some of that mess.

John Clark: That tells you that the window's getting too hot and the chemistry goes faster the hotter the system gets.

Collin McKinney: We are using the Havar foils on the front of the target with the silver and I don't really see a stalactite production either.